

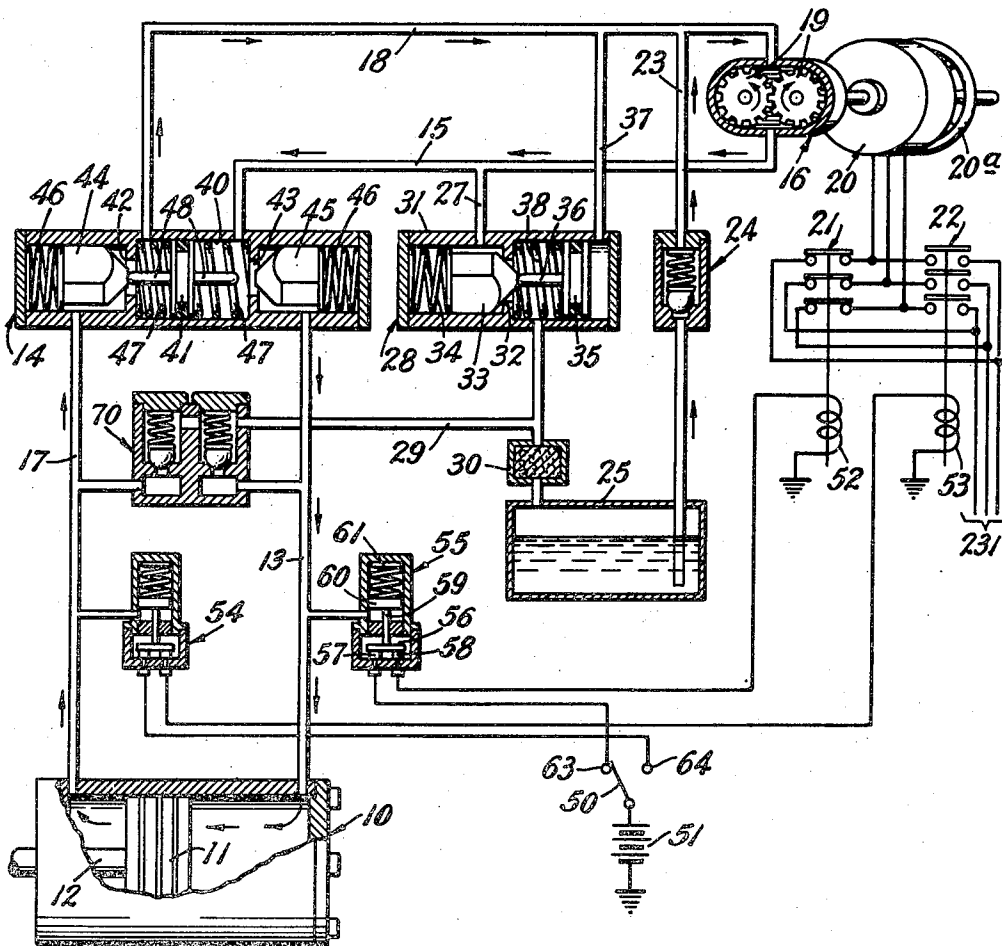
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HYDRAULIC SYSTEM

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HYDRAULIC SYSTEM

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2 Claims. (Cl. 60—52)

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This invention relates to hydraulic actuating systems in which pressure fluid is supplied to either end of a motor cylinder to shift a piston therein in one direction or the other.

This application is a division of my copending application, Serial Number 565,538, filed November 28, 1944.

An object of the invention is to provide a hydraulic actuating system employing a motor cylinder actuated by the application of pressure fluid to one end or the other, in which the mechanism for supplying pressure fluid is automatically controlled to maintain pressure in the end of the motor cylinder to which pressure fluid was last applied.

Other more specific objects and features of the invention will appear from the description to follow of a specific embodiment of the invention.

It is frequently desirable in hydraulic systems to employ hydraulic jacks comprising a cylinder containing a piston, the piston being moved in either direction by the application of pressure fluid to one end of the cylinder, fluid being simultaneously exhausted from the other end of the cylinder. A convenient mechanism for supplying the pressure fluid is a reversible pump driven by a reversible electric motor, although it is also common to employ a unidirectional pump in combination with a four-way control valve for connecting the pump output to either end of the cylinder while connecting the other end to the inlet of the pump or to a reservoir. In many applications of hydraulic motor cylinders, the piston may be actuated into one position or the other and is retained in the position for a substantial interval of time. It is old to provide locking valves on such cylinders for preventing escape of fluid from either end of the cylinder when the pump is not operating, and thereby holding the piston in the position into which it was last moved. However, as a result of leakage in the system, or contraction due to a drop in temperature, the pressure in one end or the other of the cylinder may drop below the value necessary to retain the piston in the desired position. The present invention overcomes this defect of the former systems by providing pressure switches responsive to the pressures in opposite ends of the motor cylinder for completing a circuit to start up an electrically driven pump whenever the pressure drops below a safe value. After the pressure has been restored, the switches function to open the circuit and stop the pump, so that the system is fully automatic.

A practical embodiment of the invention will now be described with reference to the drawing, the single figure of which is a schematic diagram of a system in accordance with the invention.

Referring to the drawing, there is shown a hydraulic motor cylinder 10, containing a piston 11, 60

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having a piston rod 12 which extends through the left end of the cylinder 10 for connection to a device to be actuated. The right end of the cylinder is connected, through a conduit 13 and through a locking valve 14, to a conduit 15 which extends to one port of a reversible pump 16. The left end of the cylinder 10 is connected through a conduit 17 and through the locking valve 14, to a conduit 18 which connects to the other port of the pump 16. The motor piston 10 can be driven in either direction by driving the reversible pump 16 in one direction or the other.

The pump 16 may be of any known construction, but is shown as a gear pump having two intermeshing gears 19, one of which is directly connected to the shaft of an electric motor 20, which is adapted to be rotated in one direction by closure of a switch 21, and in the opposite direction by closure of a switch 22. As is clearly shown in the diagram, the motor is of the three-phase type supplied from a three-phase line 23, and the direction of rotation of the motor is reversed by reversing any two of the three leads, as is well-known in the art.

The pump 16 ejects from its outlet port the same amount of fluid that is drawn in through the inlet port, whereas the displacements of opposite ends of the motor cylinder 10 are different. Thus, as shown in the drawing, the pump 16 is delivering fluid through conduits 15 and 13 to the large end of the motor cylinder 10, moving the piston 11 therein to the left. Because of the smaller displacement of the left end of the cylinder 10 a lesser flow of fluid is being delivered from the cylinder through conduits 17 and 18 to the inlet of the pump. If no provision were made for the supply of additional fluid to conduit 18, the operation of the pump would be impaired. The fluid deficiency is made up by providing a branch conduit 23 containing a simple check valve 24 interposed between the conduit 18 and a fluid reservoir 25. The check valve 24 preferably has a relatively light spring, so that only a very slight reduction of the pressure in conduit 18 below the atmospheric or ambient pressure is sufficient to open the check valve and permit flow of as much fluid as is necessary to compensate for the different displacements of the two ends of the motor cylinder, and maintain the inlet port of the pump filled with fluid at all times.

When the pump is driven in the reverse direction, it is delivering fluid to the conduit 18, and the pressure therein closes the check valve 24, so that there can be no escape of fluid therethrough to the reservoir 25. The fluid delivered by the pump flows through the conduit 18, the valve 14, and the conduit 17 into the left end of the motor cylinder 10, to move the piston 11 to the right. This results in the exhaust of a larger amount of fluid from the right end of the cylinder, which

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fluid flows back through the conduit 13, the valve 14, and the conduit 15. Obviously, since the flow of the fluid into conduit 15 from the motor 10 exceeds the flow being delivered by the pump 16, it cannot all return to the pump, and the excess fluid flows through a branch conduit 27, through a valve 28, into an exhaust conduit 29, and through a filter 30, into the reservoir 25.

The valve 28 is normally closed, and is held closed by pressure in conduit 15, but opens in response to pressure in conduit 18. Thus, the valve comprises a casing 31 having a partition therein defining a valve seat 32 which is normally closed by a poppet 33 urged toward the seat 32 by a compression spring 34. The right end of the casing 31 to the right of the valve seat 32 constitutes a cylinder and contains a piston 35 having a stem 36 which presses the poppet 33 open when the piston 35 moves to the left. The left end of the piston 35 is, at all times, exposed only to the low pressure existing in the exhaust conduit 29, whereas the right end of the piston 35 is exposed to the pressure existing in conduit 18, the right end of the casing 31 being connected to the conduit 18 by a branch conduit 37. A compression spring 38 moves the piston 35 to the right except when pressure fluid is being supplied to the conduit 18.

It is obvious from the foregoing description that whenever the pump is being operated in the direction to supply pressure fluid to conduit 15, the poppet 33 is held on its seat by the spring 34 and the pressure in conduit 15, so that the full output of the pump is delivered to the right end of the motor cylinder 10; at the same time the suction in the conduit 18 opens the check valve 24 to permit flow of the necessary make-up fluid to the inlet of the pump.

On the other hand, whenever the pump is running in the opposite direction to supply pressure fluid to conduit 18, the check valve 24 is closed so that the full output of the pump is delivered to the left end of the motor cylinder 10, and poppet 33 is opened by the piston 35 to by-pass excess fluid from the conduit 15 back to the reservoir 25.

As shown in the drawing, the locking valve 14 is provided in both the conduits leading to the motor cylinder 10. Such valves are not broadly new, but it is believed that their use in this particular system in combination with the control system to be described constitutes invention.

The valve 14 includes casing means defining a cylinder 40, opposite ends of which cylinder are connected to the conduits 18 and 15 respectively, and the cylinder contains a piston 41. Opposite ends of the cylinder 40 have valve seats 42 and 43 therein, both of which are closed by poppets 44 and 45 respectively when there is no differential pressure between the conduits 15 and 18. Thus, poppets 44 and 45 are constantly urged against their seats by compression springs 46, and these springs function to seat the poppets whenever the pump 16 is not running and the pressures in the conduits 15 and 18 are substantially equal, and low. However, whenever the pressure in either conduit 15 or 18 exceeds the pressure in the other conduit, which condition prevails whenever the pump is running, the piston 41 is shifted by the differential fluid pressure against the force exerted by centering springs 47, and one of two stems 48 extending from the piston opens one of the other of the poppets 44 or 45. The same pressure differential that shifts the piston 41 to open one of the poppets auto-

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matically opens the other poppet, the latter functioning as a check valve. Thus, when the pressure is high in conduit 15 and low in conduit 18, the piston 41 is moved to the left to open poppet 44, and the pressure in conduit 15 acts directly on poppet 45 to open it. On the other hand, when fluid is being supplied by the pump to conduit 18 and exhausted from conduit 15, the pressure is high in conduit 18, and the piston 41 is moved to the right to open poppet 45, and the pressure in conduit 18 functions directly to open poppet 44. The net result is that whenever the pump is running, in either direction, both poppets 44 and 45 are off their seats, but whenever the pump and the flow stop, the pressure equalizes in the conduits 15 and 18, and both the poppets 44 and 45 seat immediately to maintain pressure in the conduits 13 and 17 and hold the motor piston 11 in the position in which it has been moved.

The system disclosed is so arranged that the pump is automatically operated to move and maintain the piston 11 in one end position or the other depending upon the position of a control switch 50, which connects a source of current 51 either to a solenoid 52 which closes the switch 21, or to a solenoid 53 which closes the switch 22. These circuits from switch 50 to the solenoids 52 and 53 are completed through a pair of pressure switches 55 and 54 which are connected to conduits 13 and 17 respectively and open their contacts whenever the pressure in the associated conduit exceeds a predetermined magnitude. Thus, as shown in the drawing, each pressure switch comprises a contact bar 56 adapted to close a pair of contacts 57 and 58 and connected by a stem 59 to a piston 60 which is urged downwardly by a compression spring 61 and is exposed on its under side to the pressure existing in the conduit 13 or 17 as the case may be. When the pressure is low, the spring urges the piston down to close the bar 56 against the contacts 57 and 58, whereas when the pressure exceeds a predetermined value the piston 60 is moved upwardly to lift the bar 56 and break the circuit.

The pressure switch 55 is connected in series with the left contact 63 of the control switch 50, and the pressure switch 54 is connected in series with the right contact 64 of switch 50.

The operation of the system may be briefly traced as follows:

Assumed that it is desired to move the motor piston 11 to the left, the control switch 50 is moved to the left to close with contact 63, as shown in the drawing. This completes a circuit through the pressure switch 55 to the solenoid 52, energizing the latter to close the power switch 21 and cause the motor 20 to rotate the pump in the direction indicated by the arrows thereon. The rotation of the pump develops pressure in conduit 15 which moves the piston 41 in the locking valve 14 to the left, and also opens the poppet 45, so that the pressure fluid flows through into conduit 13 and into the right end of the motor cylinder 10, moving the piston 11 to the left. The pressure switch 55 is adjusted to open only in response to pressures in the conduit 13 in excess of the pressures required to move the piston 11 and whatever device it drives. Hence, the pressure switch does not open during movement of the motor piston, and the action continues, the fluid from the left end of the cylinder 10 being exhausted through the conduit 17 past the open poppet 44 into conduit 18 and back to the inlet port of the pump, make-up fluid being sup-

plied from the reservoir 25 through the check valve 24 as previously described. When the piston 11 reaches the left end of its stroke, the pressure in conduits 15 and 13 immediately rises to a relatively high value at which the pressure switch operates to open the circuit to the solenoid 52; it in turn permits the switch 21 to open and stop the motor and the pump. As the pump decelerates, the pressure in conduit 15 drops, but the pressure is held in conduit 13 because the poppet 45 closes in response to any tendency toward reverse flow from conduit 13 into conduit 15. Hence, the pressure switch 55 remains open. If there is no leakage and no reduction in temperature, the pressure conduit 13 may remain high enough to keep the pressure switch 55 open until such time as the switch 50 is moved to the right to shift the motor piston to the right. However, if as a result of leakage or a drop in temperature the pressure in conduit 13 drops below a predetermined value, the pressure switch 55 will again close its contacts to start the pump and run it long enough to again build the pressure up to the value at which the pressure switch opens. Hence, even if the system is left for a long period of time, the motor and pump start and stop automatically, if necessary, to maintain the pressure holding the motor piston 11 in its left position.

When it is desired to move the motor piston 11 into the right end of its stroke, the switch 50 is thrown to the right, whereupon a circuit is completed through contact 64 and through pressure switch 54 to energize the solenoid 53 and close the switch 22 to run the electric motor and the pump in the opposite direction. Under these conditions, pressure fluid is supplied to conduit 18, which moves the piston in the locking valve 14 to the right, and opens the poppet 44 to permit the fluid flow into the left end of the cylinder 10. At the same time, fluid is exhausted from the right end of the motor cylinder 10 past the poppet valve 45, since the latter is now held open by piston 41. The excess fluid is by-passed back to the reservoir through the valve 28 as previously described. When the motor piston completes its stroke, the pressure rapidly rises in the conduit 17, to open the pressure switch 54 and stop the motor and pump, whereupon the poppet 44 in the locking valve closes to maintain the pressure in the conduit 17. Should this pressure drop below the predetermined value, the electric motor will again be started up, and will run the pump long enough to rebuild the pressure to the desired value.

A handwheel 20a is provided on the motor 20 to permit operation of the pump in an emergency if the power supply should fail.

A pressure relief valve 70 is preferably provided between the conduits 17 and 13 and the exhaust conduit 29, to relieve excessive pressures that may develop in either conduit 17 or 13 as a result of a rise in temperature. The relief valves are so adjusted that they do not operate in normal service. They function to prevent damage to the system in the event of a temperature rise or in the event the electric motor should not shut down for any reason, such as stuck switches or relays.

Although for the purpose of explaining the invention a specific embodiment thereof has been described in detail, various departures from the exact construction shown can be made without departing from the invention, which is to be limited only to the extent set forth in the appended claims.

I claim:

1. In a hydraulic actuating system: a motor cylinder and piston; pump means; electrical driving means for said pump means; a pair of conduits connecting said pump means to opposite ends of said motor cylinder, said pump means being operative to exhaust fluid from one conduit and supply fluid to the other conduit; normally closed valve means in both conduits, and pressure responsive means responsive to pressure differential in said conduits on the pump side of said valve means for opening both valve means, whereby both conduits are closed to lock said motor piston against movement in response to stoppage of said pump means; and an energizing circuit for said electrical driving means including pressure switch means responsive to pressure in said motor cylinder in excess of a predetermined value for opening said circuit, said pressure switch means closing said circuit to complete the energizing circuit to said electrical driving means whenever the pressure in said motor cylinder drops below a predetermined value to cause operation of said pump means to re-establish the pressure to said predetermined value.

2. In a hydraulic actuating system: a motor cylinder and piston; a pair of conduits extending from opposite ends of said motor cylinder; pump means; electrical driving means for said pump means having a pair of control leads and responsive to energization of one of said pair of control leads for energizing said electrical driving means to cause said pump means to deliver pressure fluid to one of said conduits while exhausting fluid from the other conduit, and responsive to energization of the other of said pair of control leads for energizing said electrical driving means to cause said pump means to deliver pressure fluid to said other conduit while exhausting fluid from said one conduit; normally closed valve means in both conduits, and pressure responsive means responsive to pressure differential in said conduits on the pump side of said valve means for opening both valve means, whereby both conduits are closed to lock said motor piston against movement in response to stoppage of said pump means; means for selectedly energizing either of said control leads, a pressure switch means in each of said control leads, each pressure switch means being normally closed and opening its associated control lead in response to pressure in excess of a predetermined value; one of said pressure switch means being responsive to pressure in one end of said motor cylinder, and the other pressure switch means being responsive to pressure in the other end of said motor cylinder, and the connections being such that each pressure switch means is connected to that end of said motor cylinder to which pressure fluid is supplied by said pumping means when the associated control lead is energized.

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